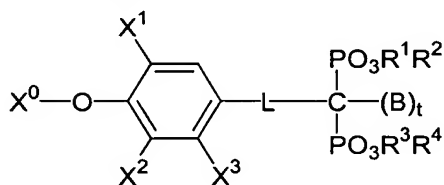


CLAIMS

1. A method for increasing the expression of dermal collagen in skin comprising the administration of an effective amount of a diphosphonate of formula (I):



(I)

wherein X^0 is H, an alkyl group having from 1 to 4 carbon atoms;

X^1 , X^2 and X^3 are identical or different and are H, a straight or branched alkyl or alkoxy group having from 1 to 8 carbon atoms,

R^1 , R^2 , R^3 and R^4 are identical or different and are H, a straight, branched or cyclic alkyl group comprising from 1 to 8 carbon atoms, or R^1 , R^2 , R^3 and R^4 may form an alkylidenedioxy ring comprising from 2 to 8 carbon atoms;

B is H, or an alkyl group having from 1 to 4 carbon atoms,

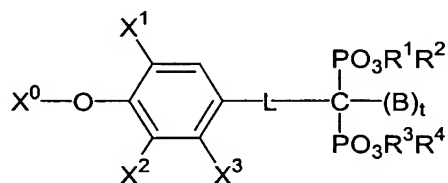
t is 0 or 1,

when t is 1 then L is $-\text{CH}=\text{CH}-\text{CH}_2-$, $-(\text{CH}_2)_n-$, $-\text{O}(\text{CH}_2)_n-$, $-\text{S}-$, $-\text{SO}_2-$, $-\text{S}(\text{CH}_2)_n-$, $-\text{SO}_2(\text{CH}_2)_n-$, where n is an integer from 1 to 7;

or when t is 0 then L is $-(\text{CH}=\text{CH})_k-(\text{CH}_2)_d-\text{CH}=-$ where k is 0 or 1 and d is an integer from 0 to 4.

2. The method of claim 1, wherein said administration is by topical application.
3. The method of claim 1, wherein X^1 and X^2 are the same and are both tert-butyl and X^0 is H.
4. The method of claim 3, wherein L is CH_2 , B is H and t is 1.
5. The method of claim 4, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.
6. The method of claim 1, wherein R^1 , R^2 , R^3 and R^4 are the same or different and are selected from hydrogen, methyl, ethyl, n-propyl, isopropyl, n-butyl, s-butyl and tert-butyl.

7. The method of claim 6, wherein R^1 , R^2 , R^3 and R^4 are identical but are not H.
8. The method of claim 7, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.
9. The method of claim 1, wherein said diphosphonate of formula (I) is tetraisopropyl 2-(3,5-di-tert-butyl-4-hydroxyphenyl)-ethylidene-1,1-diphosphonate.
10. The method of claim 1, wherein said collagen is collagen type I and/or collagen type III.
11. The method of claim 1, wherein said skin is photoaged skin.
12. The method of claim 1, wherein said skin is postmenopausal skin.
13. The method of claim 1, wherein said skin is the skin of a subject with osteoporosis.
14. The method of claim 1, further comprising administration of an effective amount of an inhibitor of matrix metalloproteinase production or activity, a retinoid, an alpha hydroxy acid or derivative thereof, an anti-oxidant, a radical scavenging agent, an anti-inflammatory agent, or a mixture thereof.
15. A method for increasing skin thickness comprising the administration of an effective amount of a diphosphonate of formula (I):



(I)

wherein X^0 is H, an alkyl group having from 1 to 4 carbon atoms;
 X^1 , X^2 and X^3 are identical or different and are H, a straight or branched alkyl or alkoxy group having from 1 to 8 carbon atoms,

R^1 , R^2 , R^3 and R^4 are identical or different and are H, a straight, branched or cyclic alkyl group comprising from 1 to 8 carbon atoms, or R^1 , R^2 , R^3 and R^4 may form an alkylidenedioxy ring comprising from 2 to 8 carbon atoms;

B is H, or an alkyl group having from 1 to 4 carbon atoms,

t is 0 or 1,

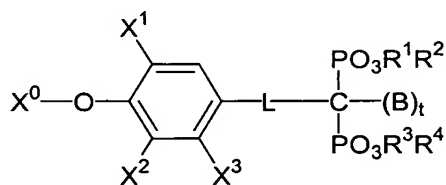
when t is 1 then L is $-\text{CH}=\text{CH}-\text{CH}_2-$, $-(\text{CH}_2)_n-$, $-\text{O}(\text{CH}_2)_n-$, $-\text{S}-$, $-\text{SO}_2-$, $-\text{S}(\text{CH}_2)_n-$, $-\text{SO}_2(\text{CH}_2)_n-$, where n is an integer from 1 to 7;

or when t is 0 then L is $-(\text{CH}=\text{CH})_k-(\text{CH}_2)_d-\text{CH}=-$ where k is 0 or 1 and d is an integer from 0 to 4.

16. The method of claim 15, wherein said administration is by topical application.
17. The method of claim 15, wherein X^1 and X^2 are the same and are both tert-butyl and X^0 is H.
18. The method of claim 17, wherein L is CH_2 , B is H and t is 1.
19. The method of claim 18, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.
20. The method of claim 15, wherein R^1 , R^2 , R^3 and R^4 are the same or different and are selected from hydrogen, methyl, ethyl, n-propyl, isopropyl, n-butyl, s-butyl and tert-butyl.
21. The method of claim 20, wherein R^1 , R^2 , R^3 and R^4 are identical but are not H.
22. The method of claim 21, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.
23. The method of claim 15, wherein said diphosphonate of formula (I) is tetraisopropyl 2-(3,5-di-tert-butyl-4-hydroxyphenyl)-ethylidene-1,1-diphosphonate.
24. The method of claim 15, wherein said skin is postmenopausal skin.
25. The method of claim 15, wherein said skin is the skin of a subject with osteoporosis.

26. The method of claim 15, further comprising administration of an effective amount of an inhibitor of matrix metalloproteinase production or activity, a retinoid, an alpha hydroxy acid or derivative thereof, an anti-oxidant, a radical scavenging agent, an anti-inflammatory agent, or a mixture thereof.

27. A method for retarding and /or reversing the formation of fine lines and wrinkles in photoaged skin in a human subject requiring such treatment comprising the administration of an effective amount of a diphosphonate of formula (I):



(I)

wherein X^0 is H, an alkyl group having from 1 to 4 carbon atoms;

X^1 , X^2 and X^3 are identical or different and are H, a straight or branched alkyl or alkoxy group having from 1 to 8 carbon atoms,

R^1 , R^2 , R^3 and R^4 are identical or different and are H, a straight, branched or cyclic alkyl group comprising from 1 to 8 carbon atoms, or R^1 , R^2 , R^3 and R^4 may form an alkylidenedioxy ring comprising from 2 to 8 carbon atoms;

B is H, or an alkyl group having from 1 to 4 carbon atoms,

t is 0 or 1,

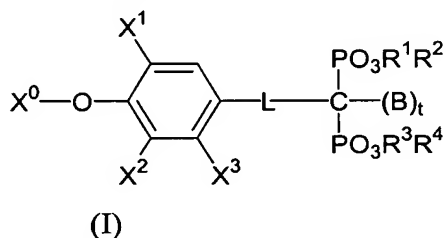
when t is 1 then L is $-\text{CH}=\text{CH}-\text{CH}_2-$, $-(\text{CH}_2)_n-$, $-\text{O}(\text{CH}_2)_n-$, $-\text{S}-$, $-\text{SO}_2-$, $-\text{S}(\text{CH}_2)_n-$, $-\text{SO}_2(\text{CH}_2)_n-$, where n is an integer from 1 to 7;

or when t is 0 then L is $-(\text{CH}=\text{CH})_k-(\text{CH}_2)_d-\text{CH}=-$ where k is 0 or 1 and d is an integer from 0 to 4.

28. The method of claim 27, wherein said administration is by topical application.

29. The method of claim 27, wherein X^1 and X^2 are the same and are both tert-butyl and X^0 is H.

30. The method of claim 29, wherein L is CH₂, B is H and t is 1.
31. The method of claim 30, wherein R¹, R², R³ and R⁴ are isopropyl.
- 5 32. The method of claim 27, wherein R¹, R², R³ and R⁴ are the same or different and are selected from hydrogen, methyl, ethyl, n-propyl, isopropyl, n-butyl, s-butyl and tert-butyl.
33. The method of claim 32, wherein R¹, R², R³ and R⁴ are identical but are not H.
- 10 34. The method of claim 33, wherein R¹, R², R³ and R⁴ are isopropyl.
35. The method of claim 27, wherein said diphosphonate of formula (I) is tetraisopropyl 2-(3,5-di-tert-butyl-4-hydroxyphenyl)-ethylidene-1,1- diphosphonate.
- 15 36. The method of claim 27, further comprising administration of an effective amount of an inhibitor of matrix metalloproteinase production or activity, a retinoid, an alpha hydroxy acid or derivative thereof, an anti-oxidant, a radical scavenging agent, an anti-inflammatory agent, or a mixture thereof.
- 20 37. A topical pharmaceutical composition comprising a pharmaceutically acceptable topical carrier and a compound of formula (I):



wherein X⁰ is H, an alkyl group having from 1 to 4 carbon atoms;

- 25 X¹, X² and X³ are identical or different and are H, a straight or branched alkyl or alkoxy group having from 1 to 8 carbon atoms,

R^1 , R^2 , R^3 and R^4 are identical or different and are H, a straight, branched or cyclic alkyl group comprising from 1 to 8 carbon atoms, or R^1 , R^2 , R^3 and R^4 may form an alkylidenedioxy ring comprising from 2 to 8 carbon atoms;

B is H, or an alkyl group having from 1 to 4 carbon atoms,

t is 0 or 1,

when t is 1 then L is $-\text{CH}=\text{CH}-\text{CH}_2-$, $-(\text{CH}_2)_n-$, $-\text{O}(\text{CH}_2)_n-$, $-\text{S}-$, $-\text{SO}_2-$, $-\text{S}(\text{CH}_2)_n-$, $-\text{SO}_2(\text{CH}_2)_n-$, where n is an integer from 1 to 7;

or when t is 0 then L is $-(\text{CH}=\text{CH})_k-(\text{CH}_2)_d-\text{CH}=-$ where k is 0 or 1 and d is an integer from 0 to 4;

wherein the said compound of formula (I) is in an amount effective to increase the expression of dermal collagen when applied to skin.

38. The composition of claim 37, wherein X^1 and X^2 are the same and are both tert-butyl and X^0 is H.

39. The composition of claim 38, wherein L is CH_2 , B is H and t is 1.

40. The composition of claim 38, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.

41. The composition of claim 37, wherein R^1 , R^2 , R^3 and R^4 are the same or different and are selected from hydrogen, methyl, ethyl, n-propyl, isopropyl, n-butyl, s-butyl and tert-butyl.

42. The composition of claim 41, wherein R^1 , R^2 , R^3 and R^4 are identical but are not H.

43. The composition of claim 42, wherein R^1 , R^2 , R^3 and R^4 are isopropyl.

44. The composition of claim 37, wherein said diphosphonate of formula (I) is tetraisopropyl 2-(3,5-di-tert-butyl-4-hydroxyphenyl)-ethylidene-1,1-diphosphonate.

45. The composition of claim 37, further comprising an additional component selected from an inhibitor of matrix metalloproteinase production or activity, a retinoid, an alpha hydroxy acid

or derivative thereof, an anti-oxidant, a radical scavenging agent, an anti-inflammatory agent, or a mixture thereof.